Climate & Floods in the West

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Climate & Floods in the West - Overview

- Unique dataset - high level of spatial resolution.
- 21 days: 50 percent of insured losses from 1978 to 2003.
- Definite winter flood season: 84 percent of damages occur in the winter months of October through March.
- Damages exhibit a high degree of spatial coherence.
- Strong ENSO dipole: the greatest losses in the Pacific North West occur in La Nina years, and in Southern California in El Nino years.
- ENSO phase can be used to predict claims and payments. A clear signal appears as early as August.

Climate & Floods in the West - Overview

- Remaining variability in damages can be linked to intraseasonal climate variation, and extra-tropical storm events, which are typically not predictable beyond several days to a week.

- The predictable component of damages could be used to improve pricing of contracts and to mitigate against losses.

- Potential problems of intertemporal adverse selection strengthen the argument for mandatory purchase of flood insurance in flood hazard areas.

- Insured losses are a small component of total flood damages, but patterns in insured losses should reflect patterns in wider flood losses.

- The regional methods developed in this paper could be used in other areas.

Time Series of Daily Claims
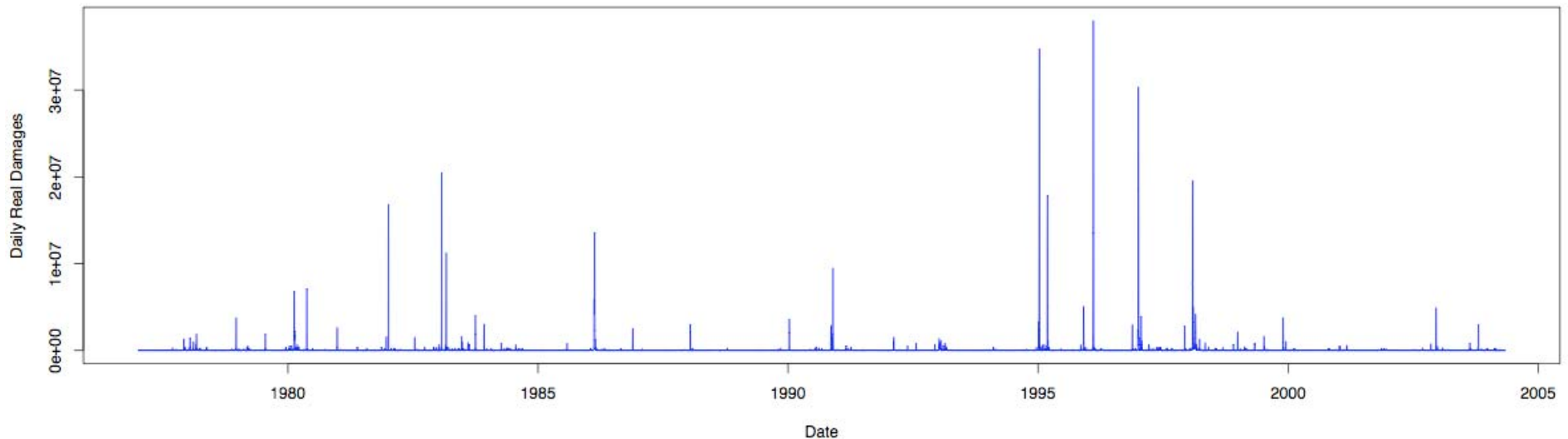
A small number of large events generate most of the damages.
From 1978 to 2004: 17 days with over $10m in real damages.

Time Series of Daily Claims

- A small number of events account for most of the damages
- 21 days (0.2 percent) account for over 50 percent of the damages
- 342 days (3.6 percent) account for over 90 percent of the damages

Distribution of Daily Damages

Log Real Damages

Days in order of decreasing damages
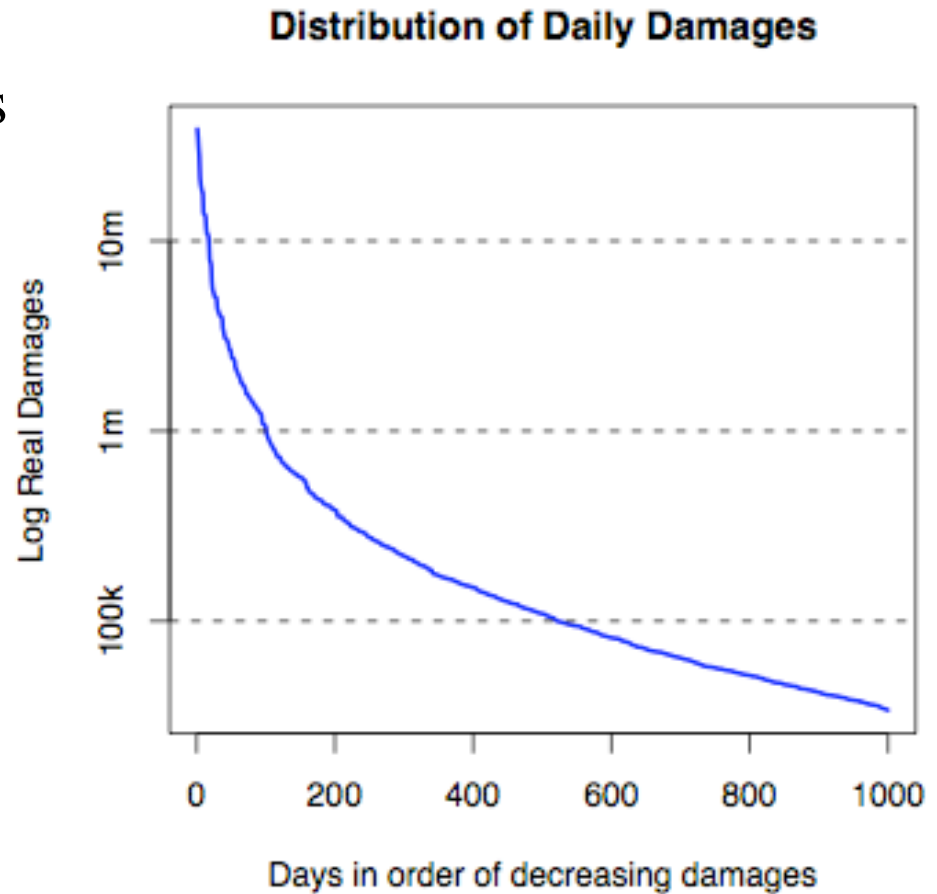
All West, Pacific Northwest, Northern California, Southern California
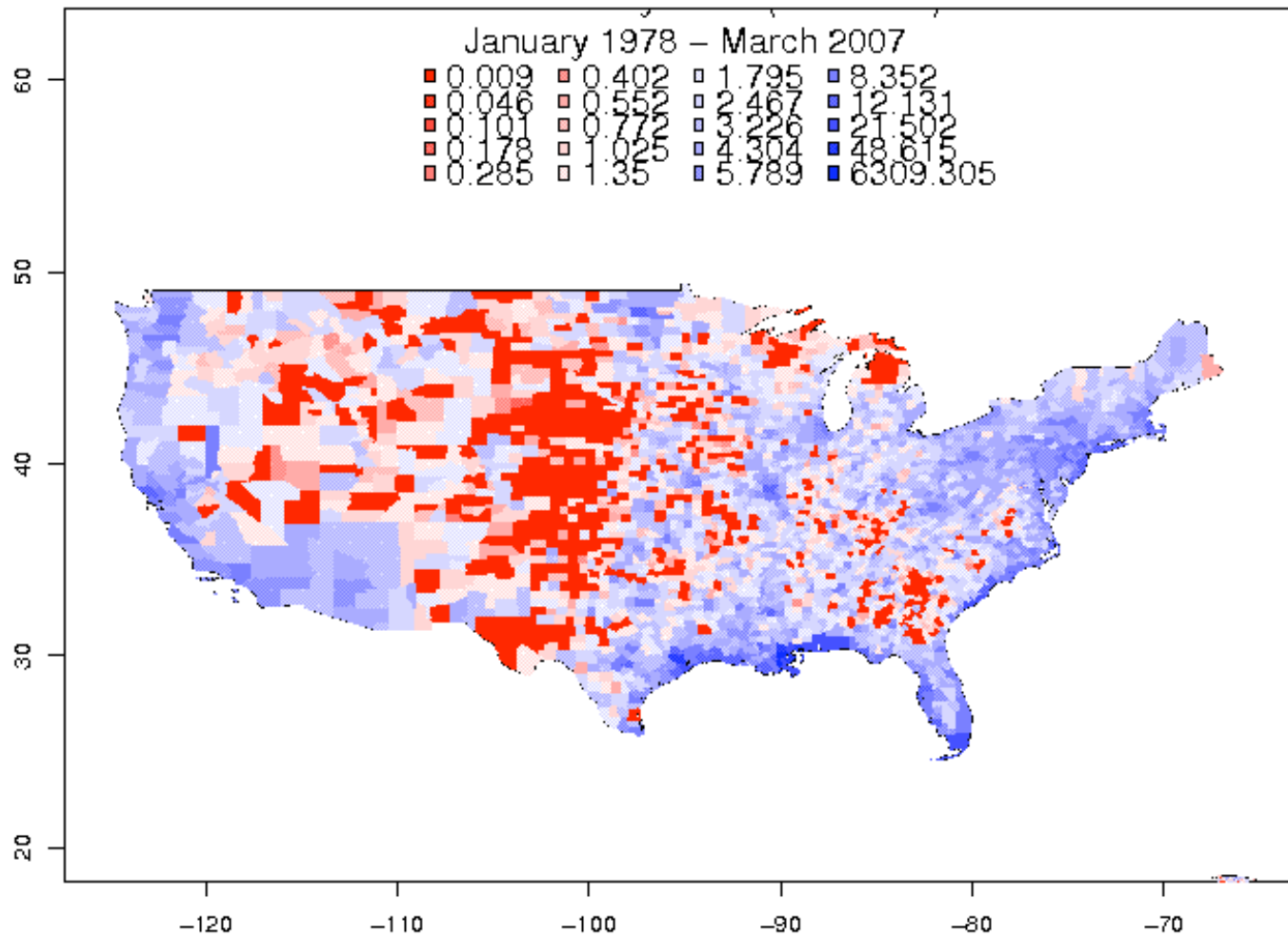
Spatial Composition of Claims

Total Real Winter Payments, 1978 – 2003
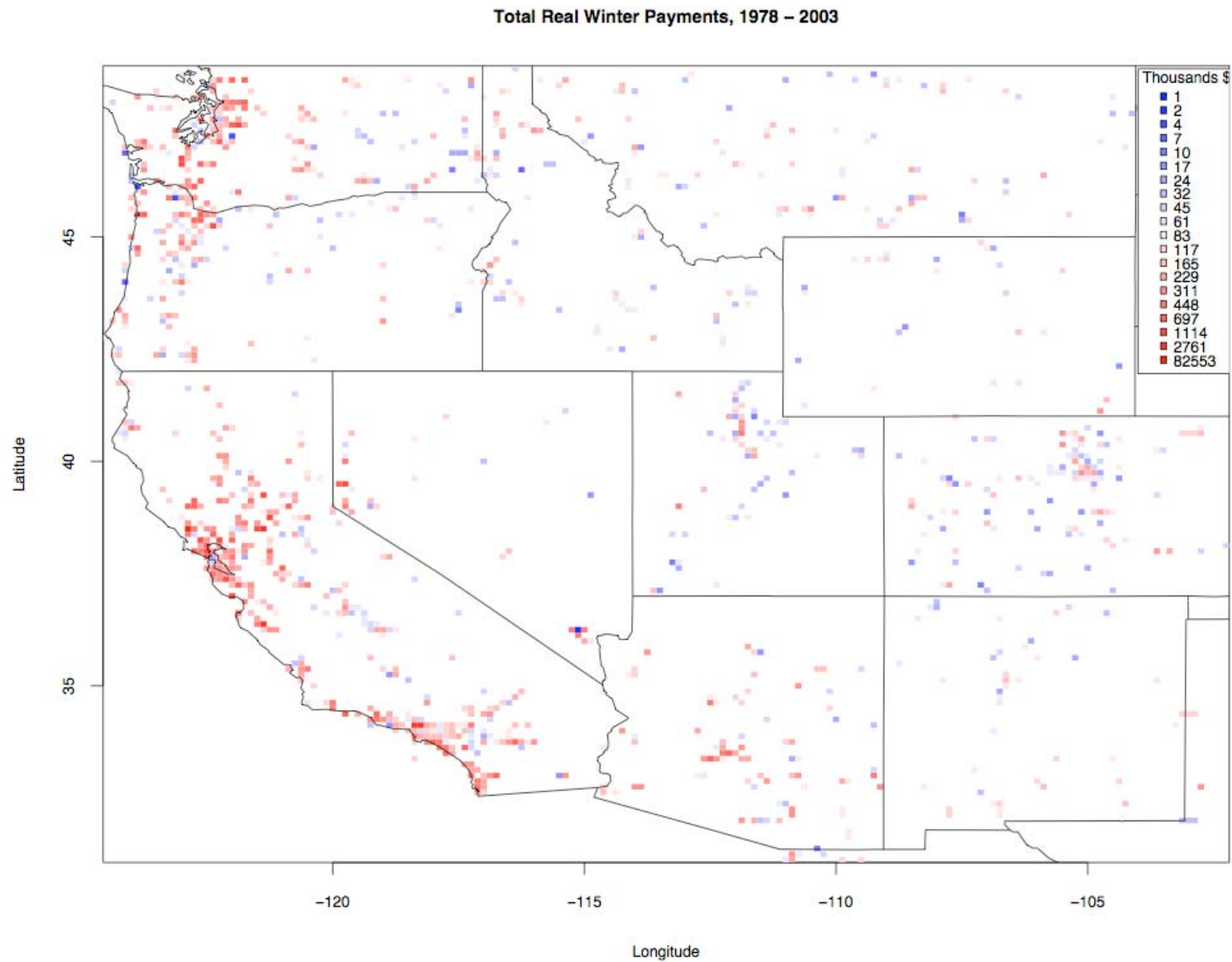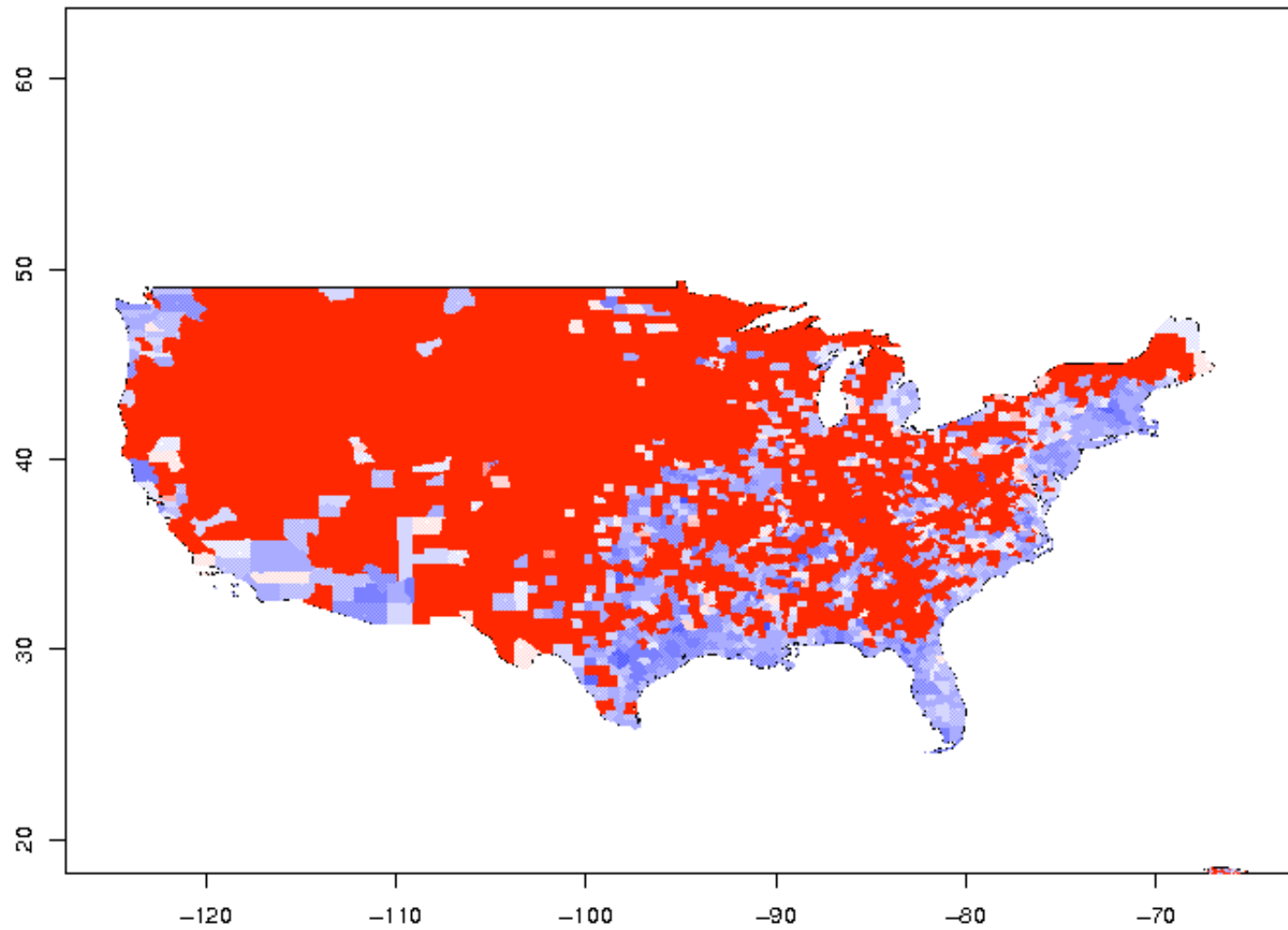
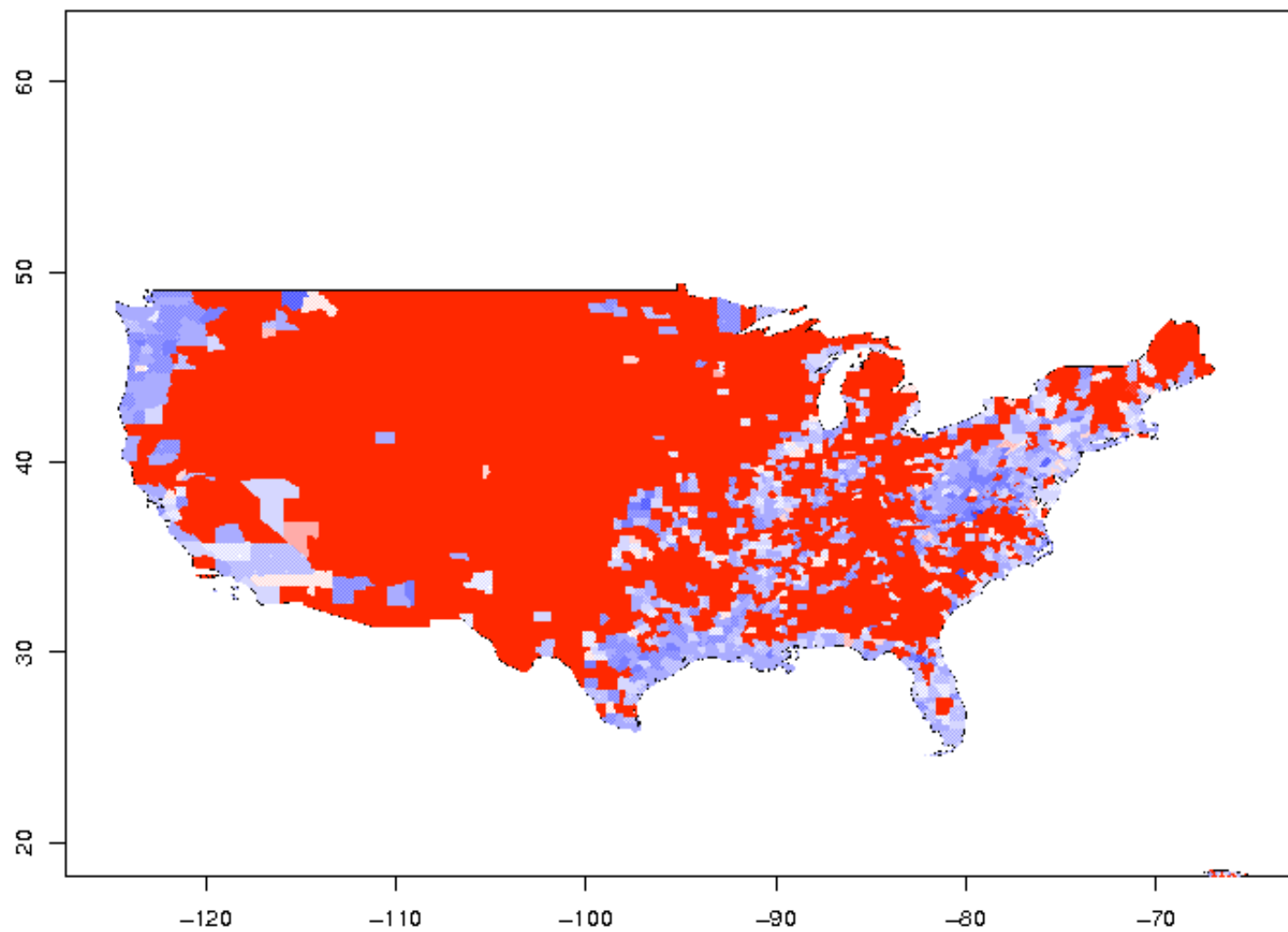# Spatial Composition of Claims by County
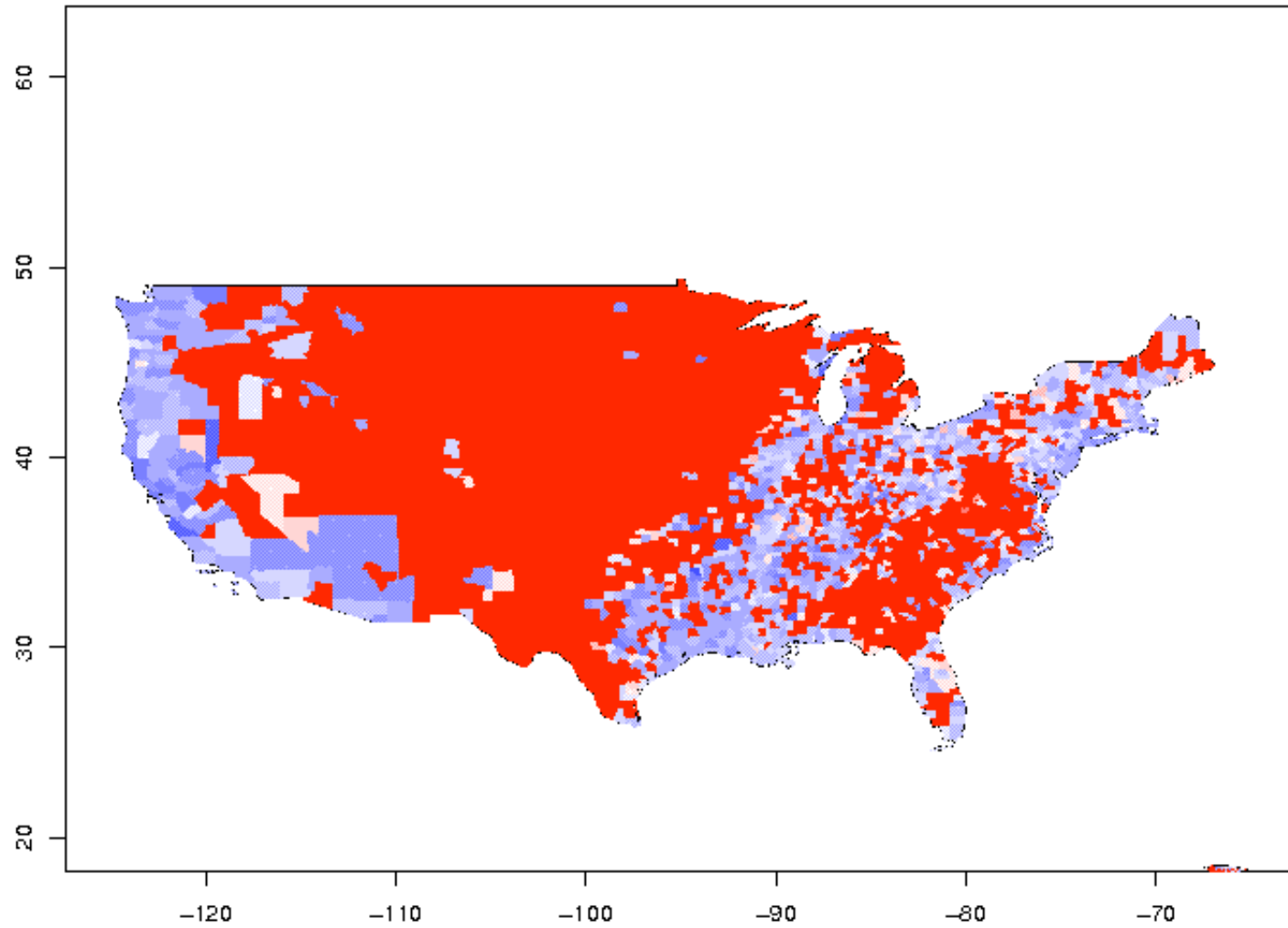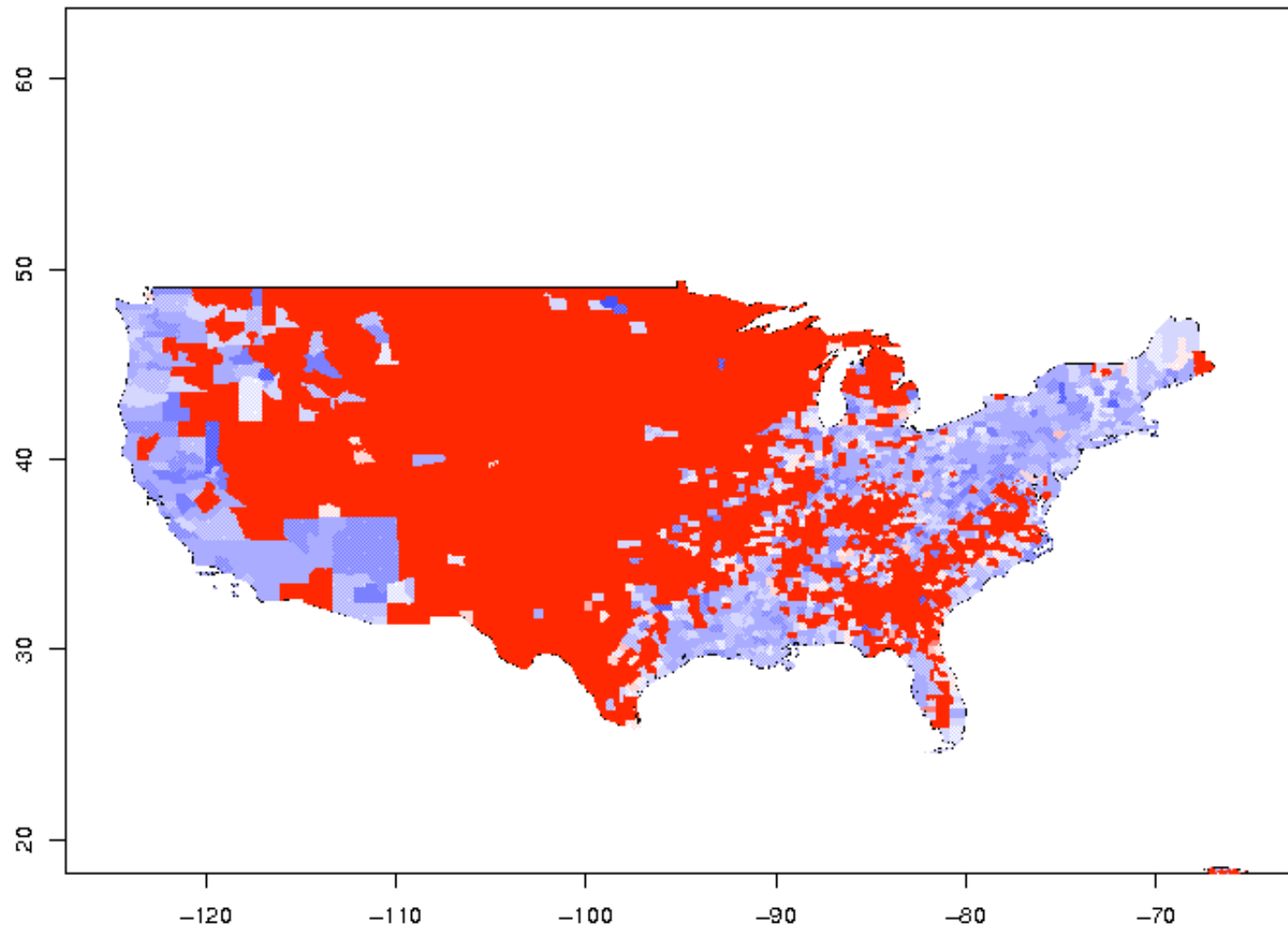# National Data 1978 - 2007

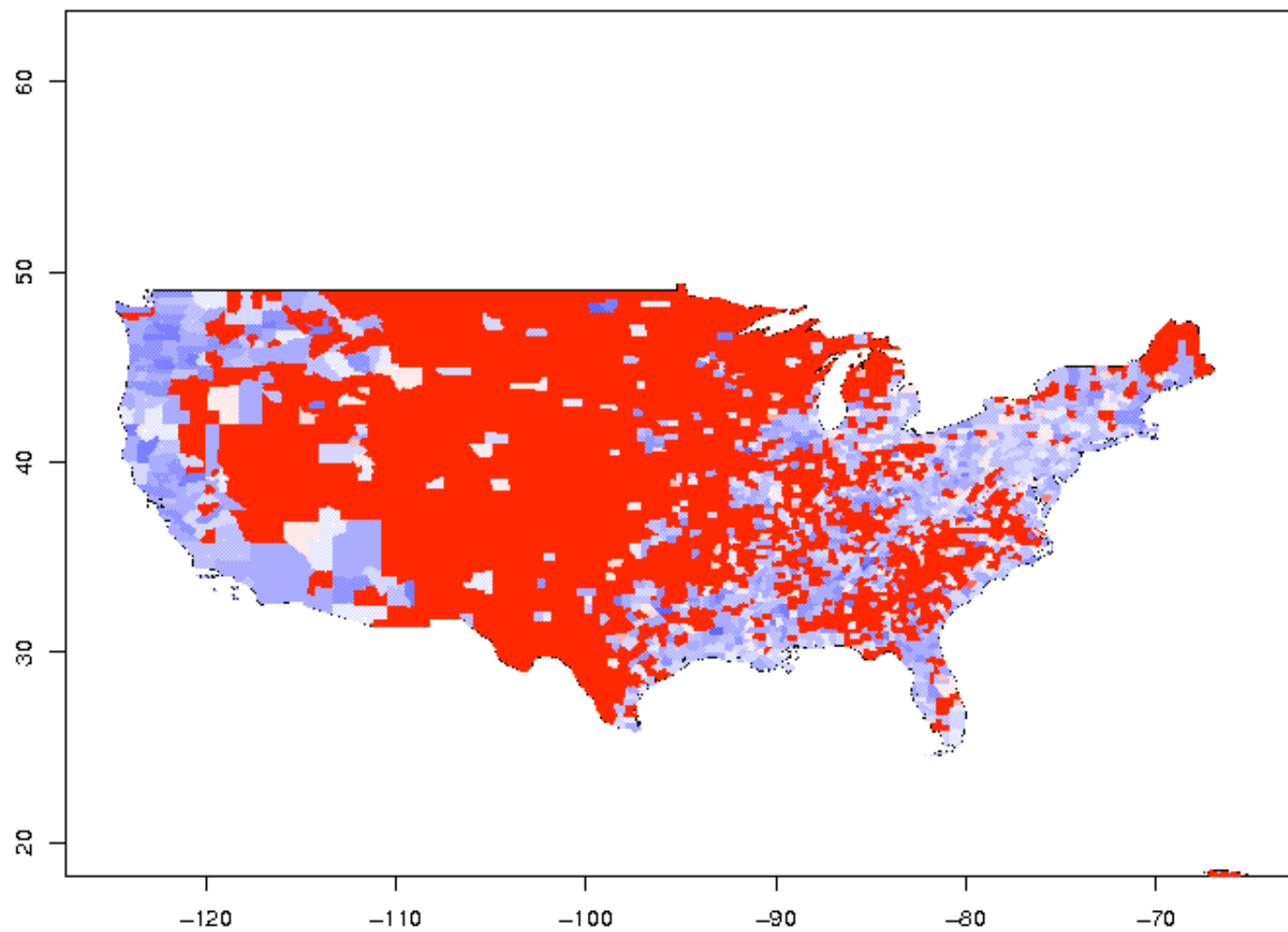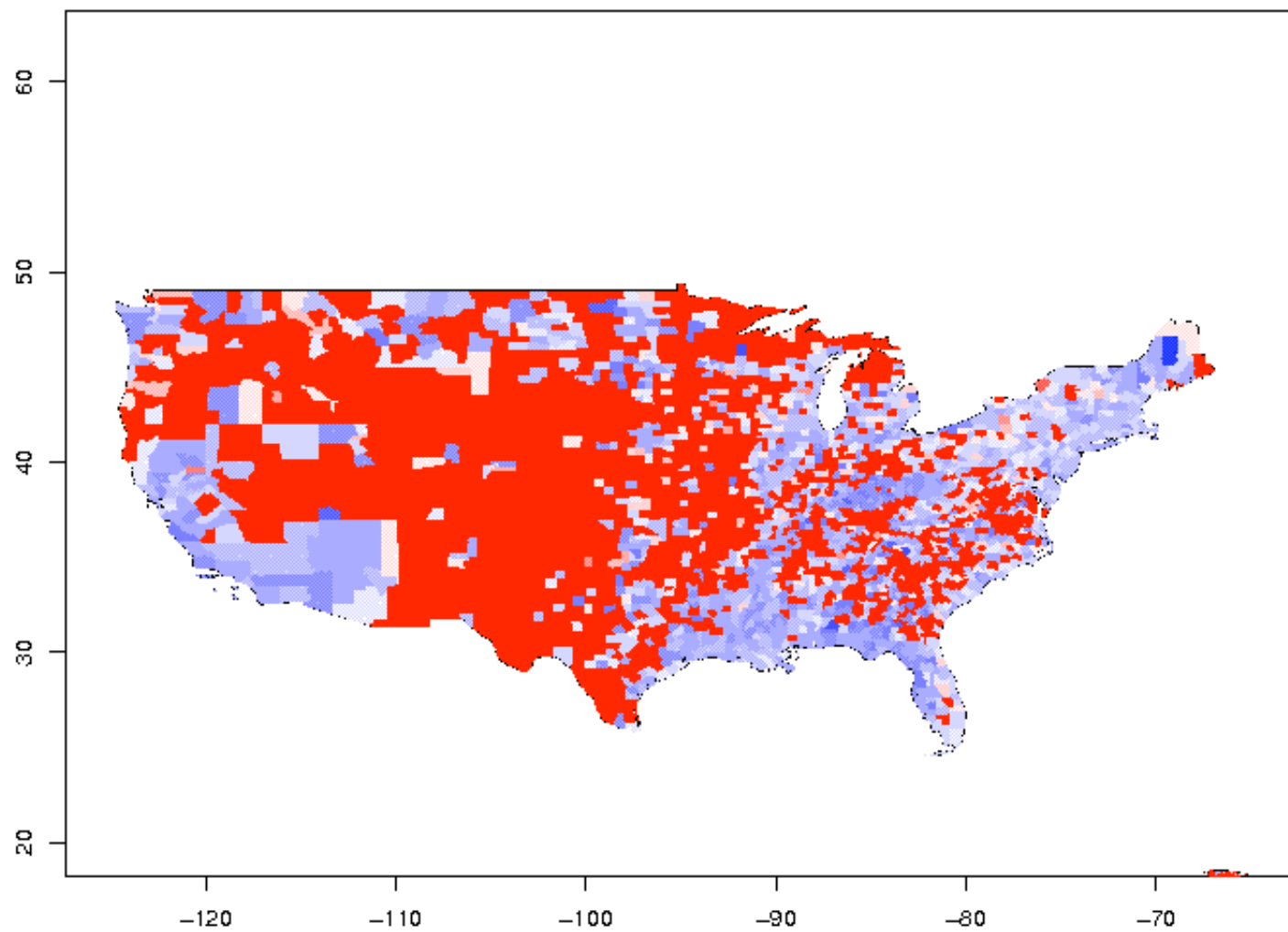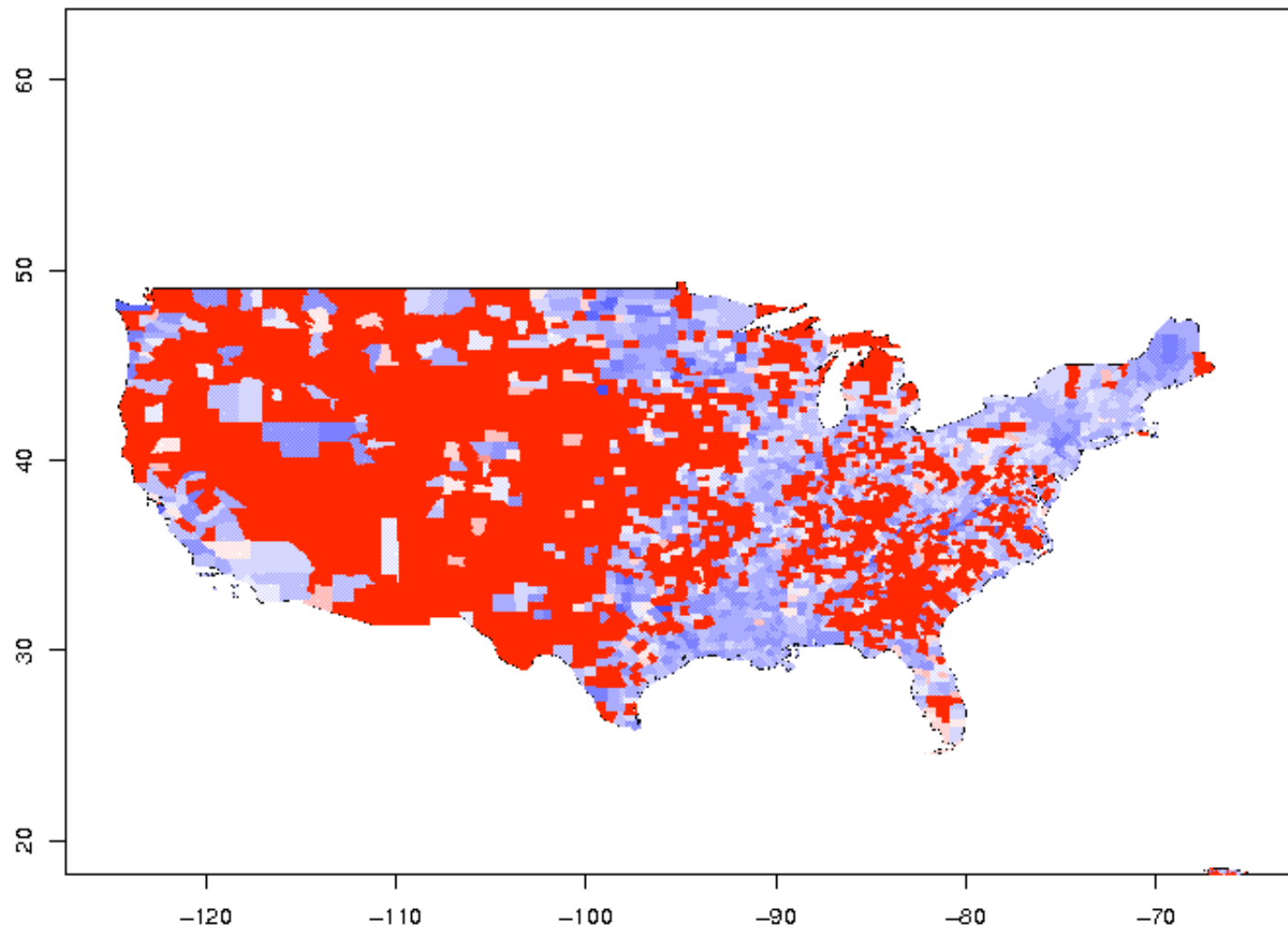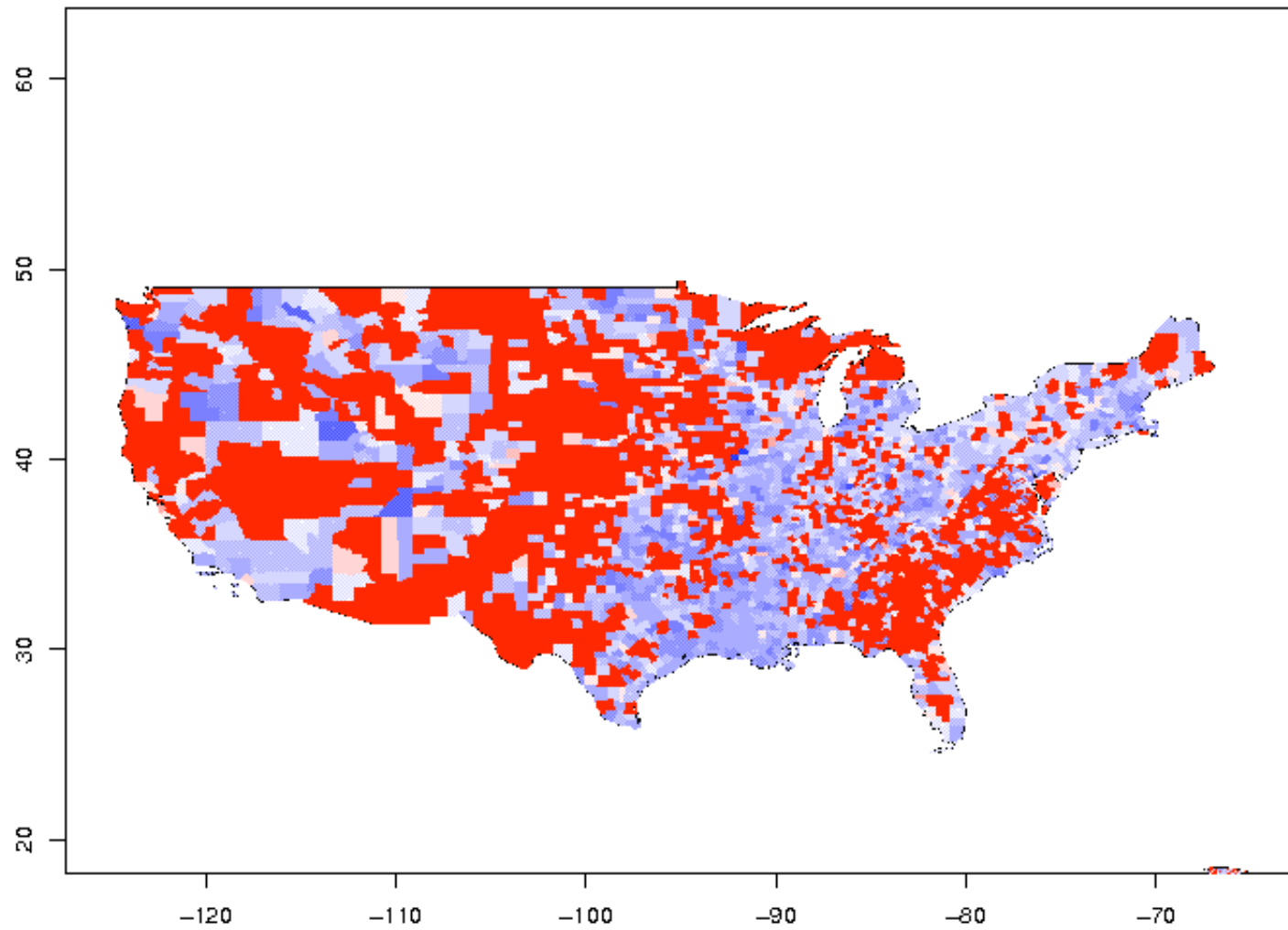Total Real Insured Losses by County, 1978 – 2007

October
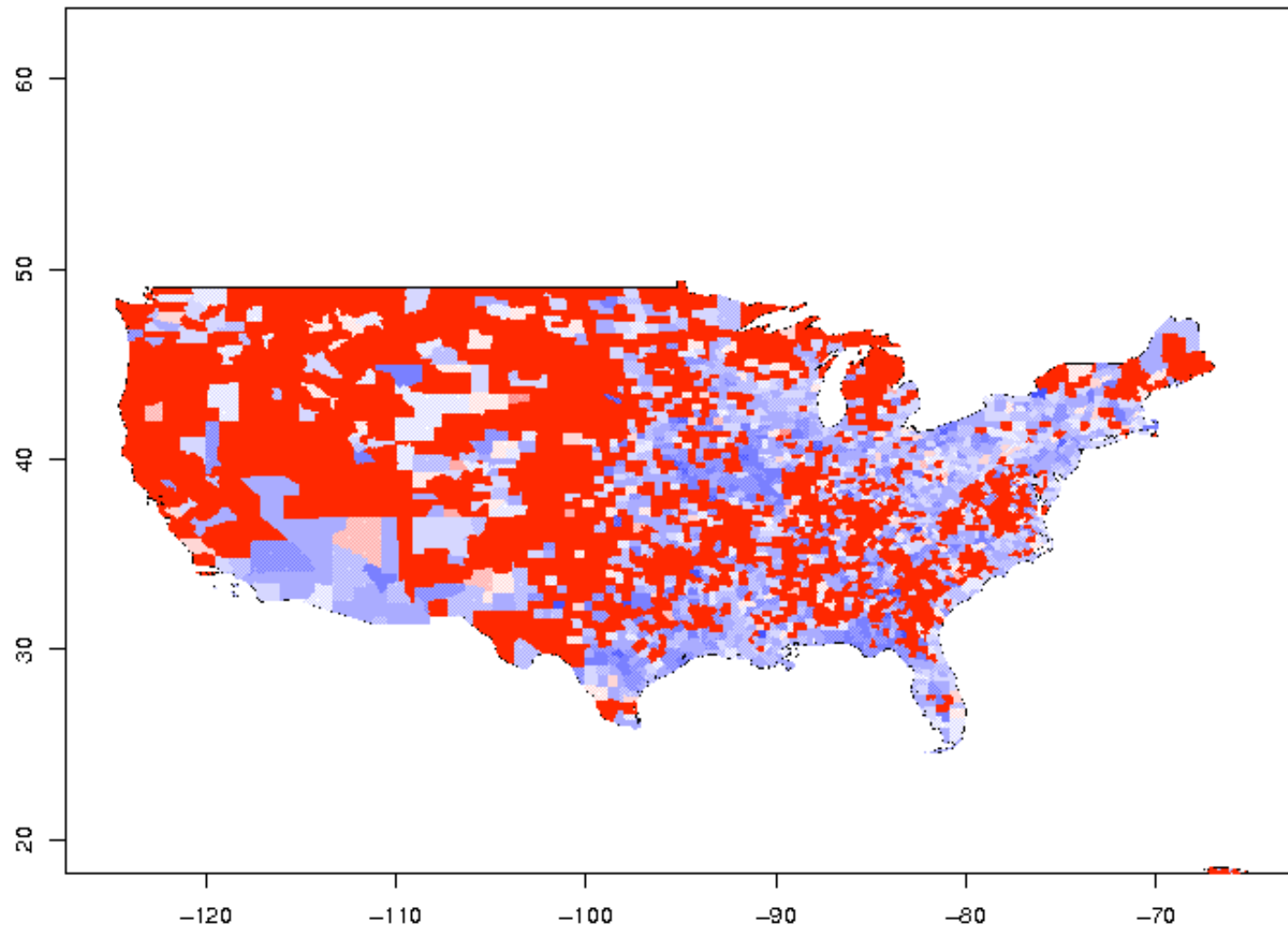
November

December

January

February

March

April

May

June
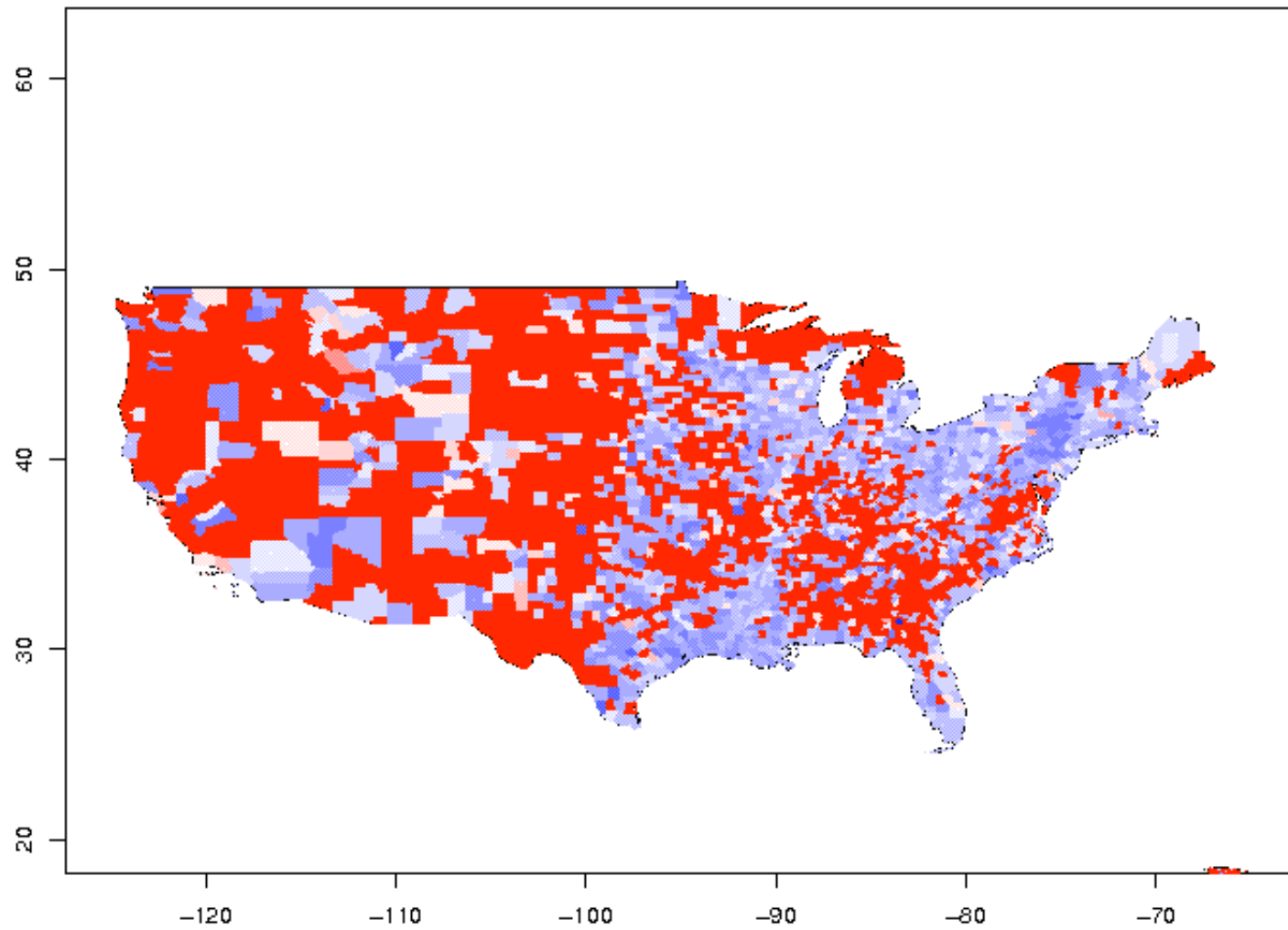
July

August
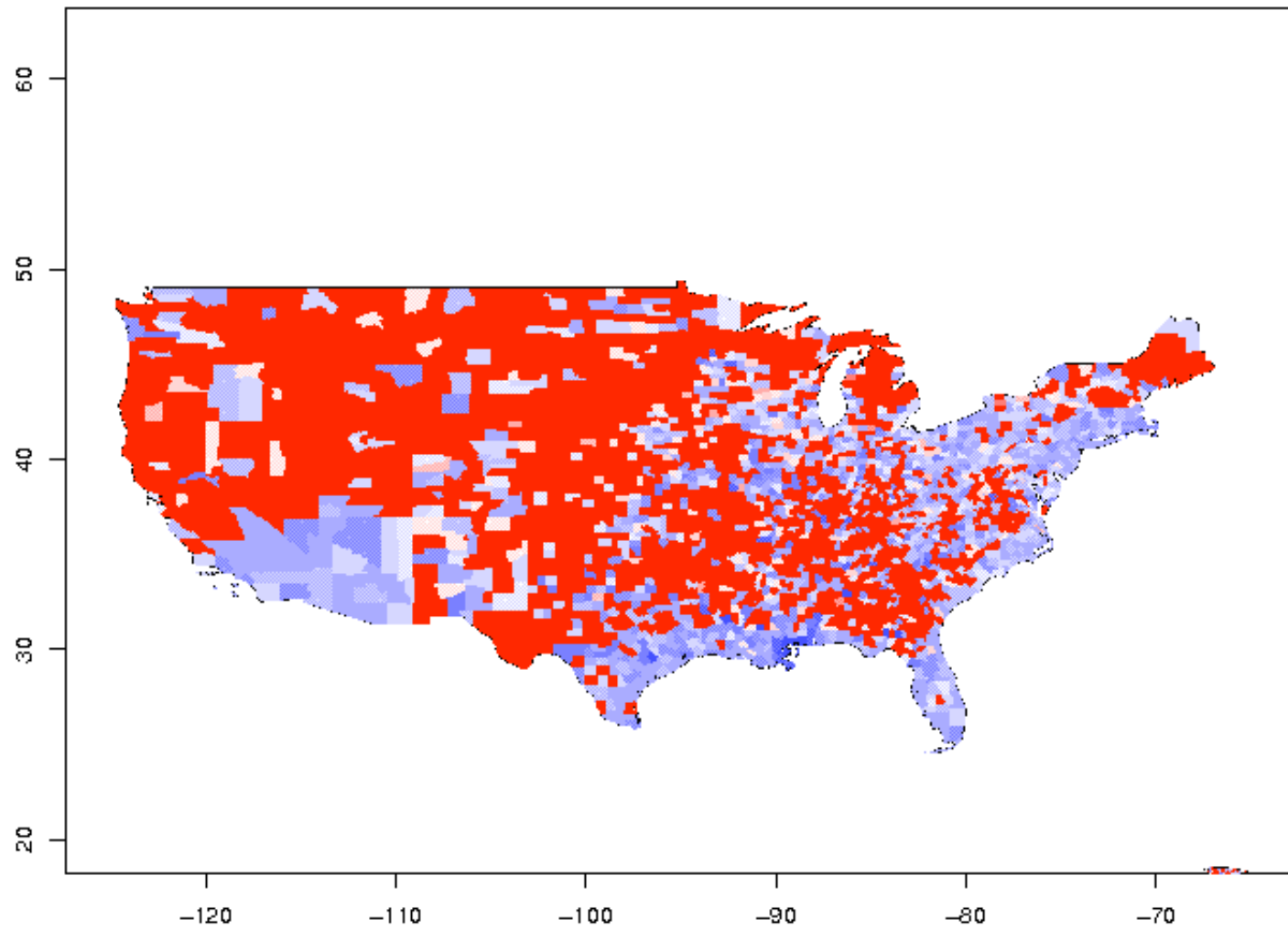
September
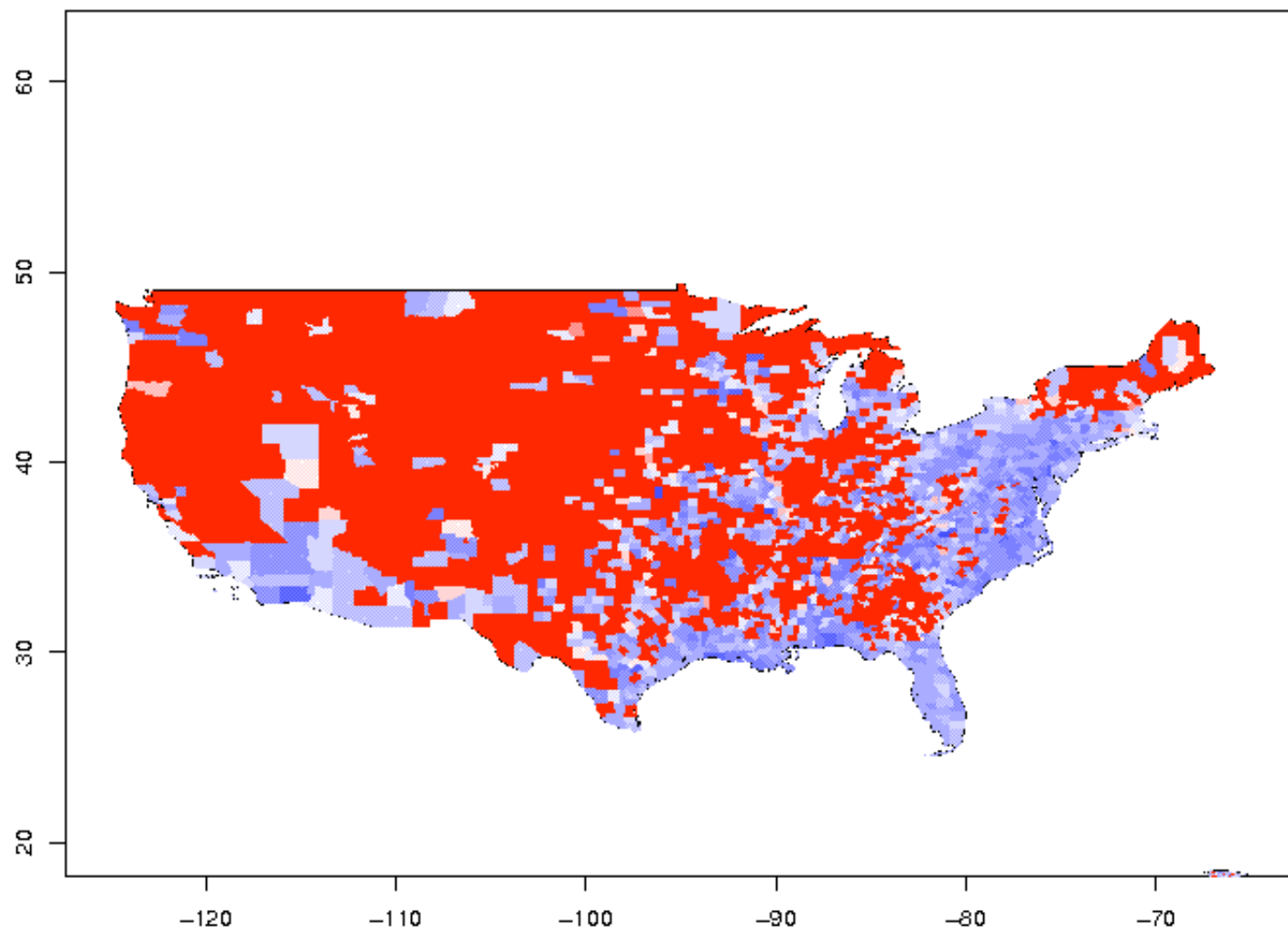
October
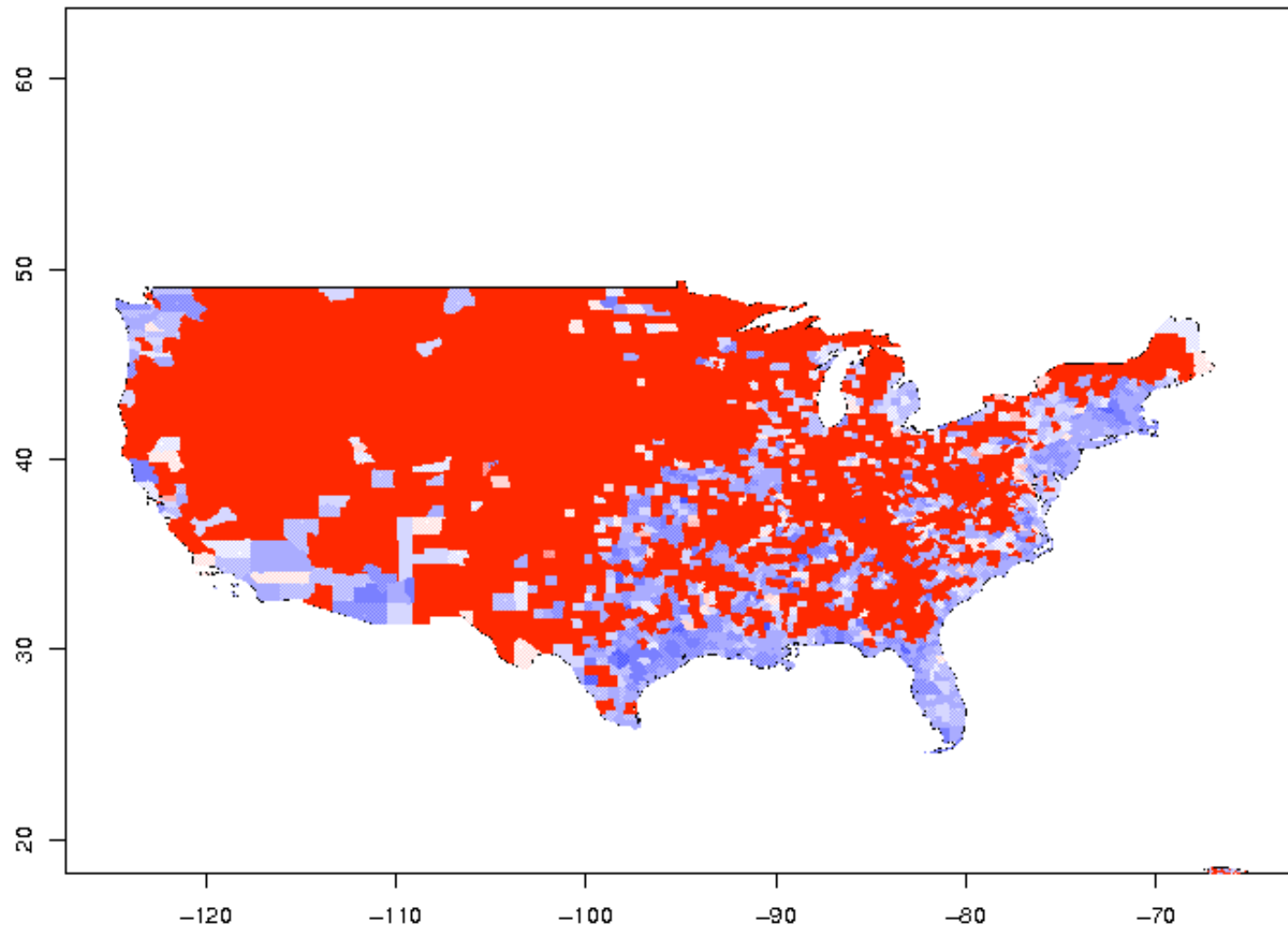
Principal Components

Principal Components of Log Real Payouts by Month over a 1/8 Degree Grid
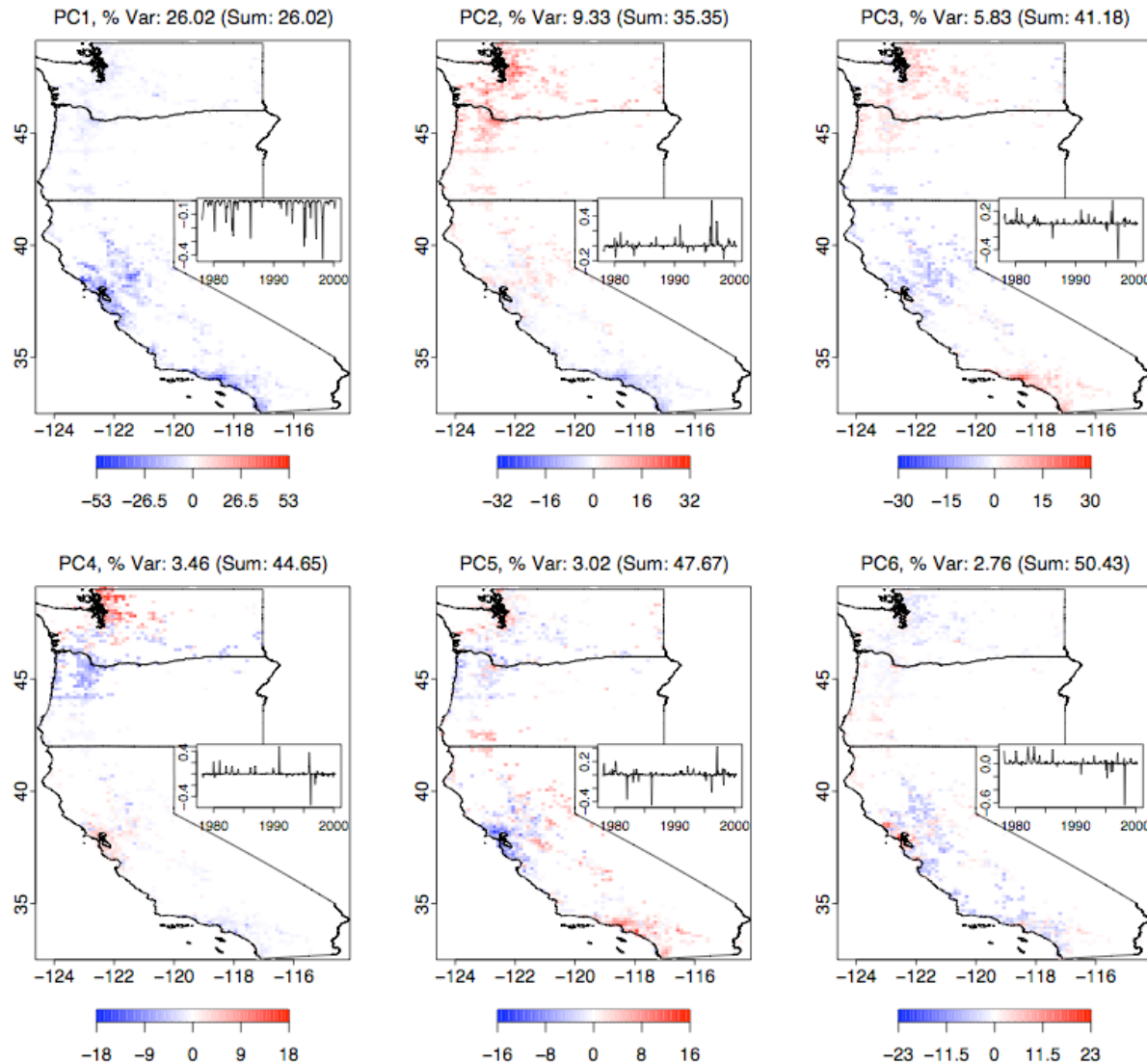
Note: PCA mean uncentered, variance unscaled

Precipitation and Claims

- We combine flood claims data on a 1/8 degree grid with VIC hydrology model precipitation and temperature data from 1978 to 1999.

- Unsurprisingly, high claims activity is correlated with high precipitation. The link is strongest on the day of the claim.

- Mean precipitation for all claims: 37.52 mm

  Mean precipitation for claims > $50,000: 44.53 mm

  1 day before loss: 30.78 mm

  2 days before loss: 20.11 mm

  3 days before loss: 14.82 mm

  4 days before loss: 11.84 mm

- 90 days before claim: 420.6 mm

- 90 days before claim, claims > $50,000: 465.6 mm

Temperature and Claims

- Minimum daily temperature is also positively correlated with magnitude of damages.
- Mean min temperature, all claims: 8.04 C
- Mean min temperature, claims > $50,000: 8.43 C

    1 day before loss: 7.94 C

    2 days before loss: 6.57 C

    3 days before loss: 5.45 C

    4 days before loss: 4.66 C

Stream Flow and Claims

- We link claims data to USGS streamflow records: each claim linked to nearest stream gage.

- High stream flow is correlated with high damages, and the strongest correlation is on the day of the loss.

- Mean streamflow, all claims: 203.45

  Mean streamflow, claims > $50,000: 306.52

  1 day before loss: 250.76

  2 days before loss: 157.63

  3 days before loss: 119.54

  4 days before loss: 102.66

Climate Indices and Claims

- We examine correlations between a variety of monthly climate indices and claims and damages.

- The ENSO signal is particularly strong, both contemporaneously and several months in advance.

- In the next slide, we present contemporaneous log damages over the Western U.S. occurring in winter months with MEI in its upper third and lower third over our sample time period of 1978 - 2004.

- In the two slides following we show predictive densities of winter log damages in Washington, Oregon, Northern and Southern California, given MEI signals from August and September.

MEI - Red: El Niño, Blue: La Niña

Winter Claims, 1978 – 2003 (Blue: mei < −0.168, Red: mei > 1.085)
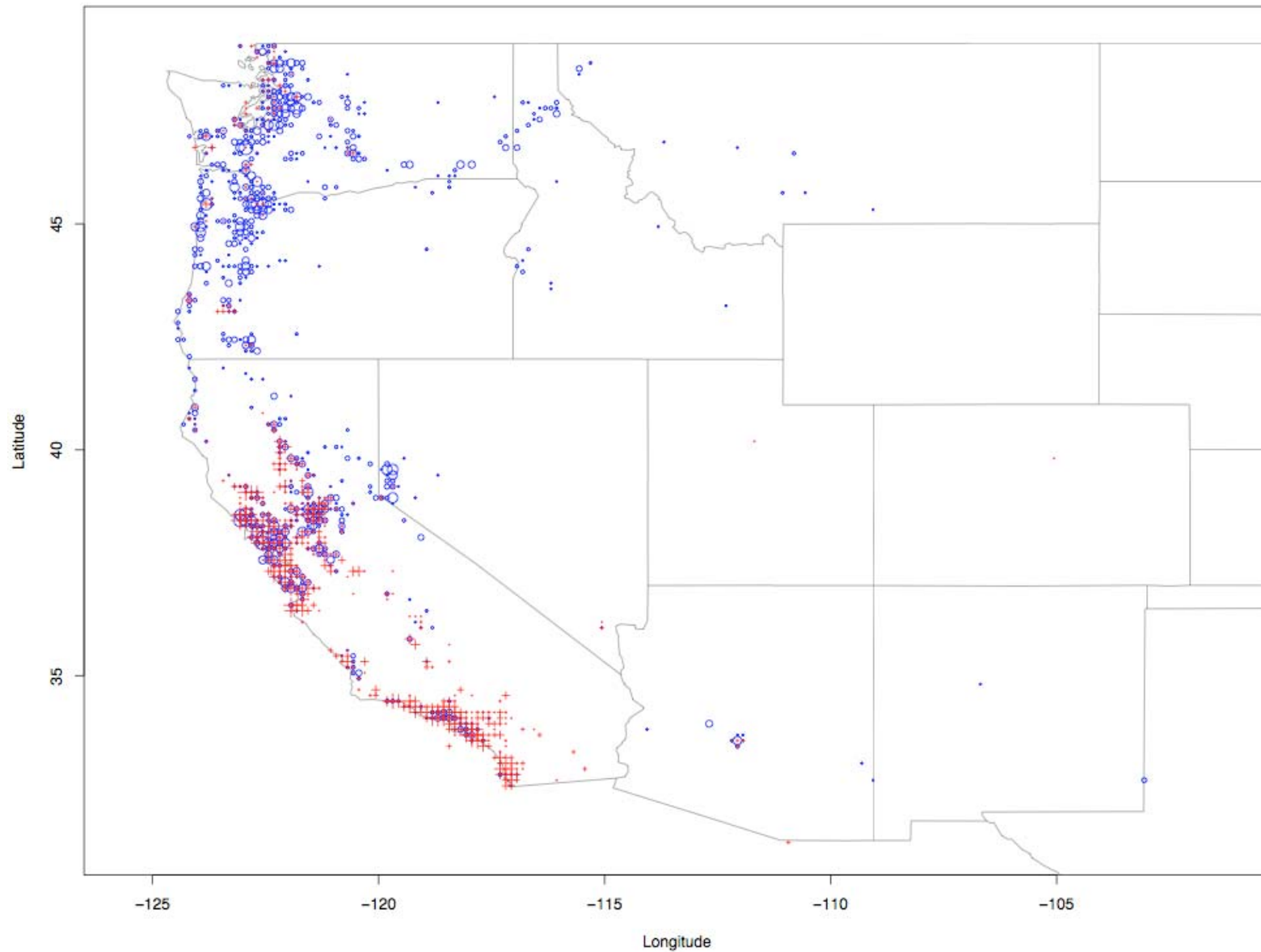
August/September Predictive Winter Claims
Densities: Washington & Oregon
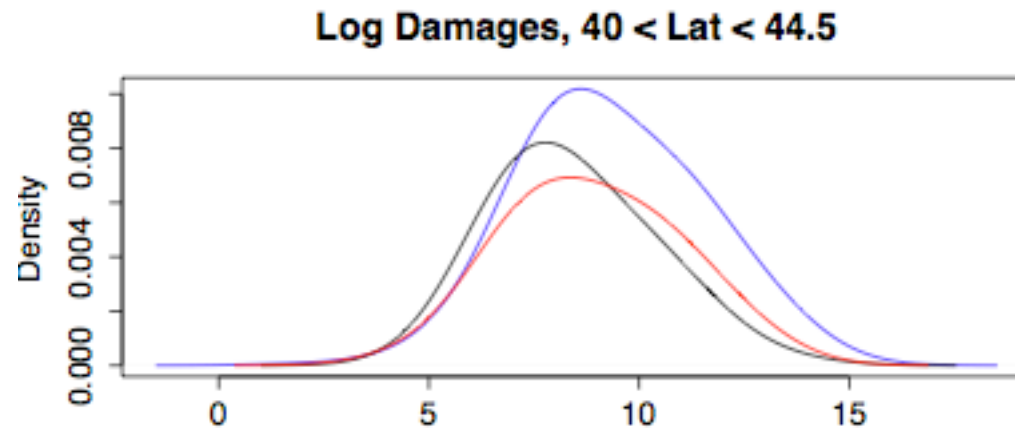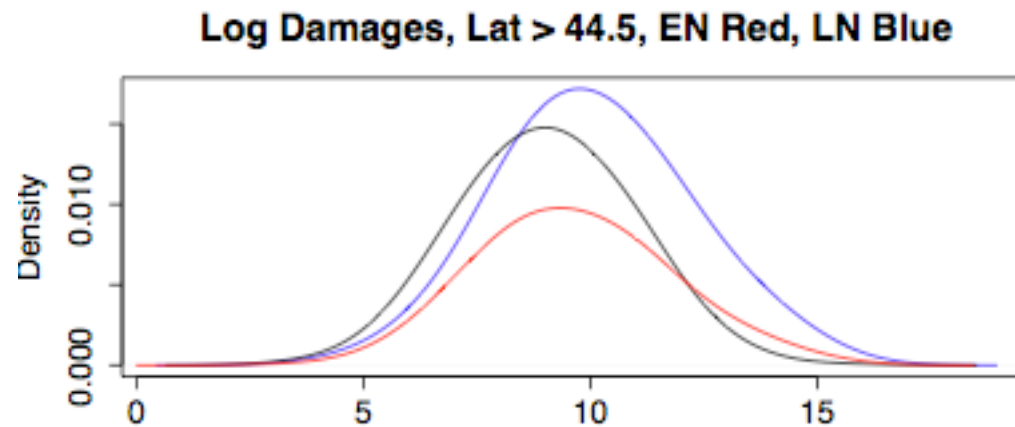
August/September Predictive Winter Claims Densities: Northern and Southern California
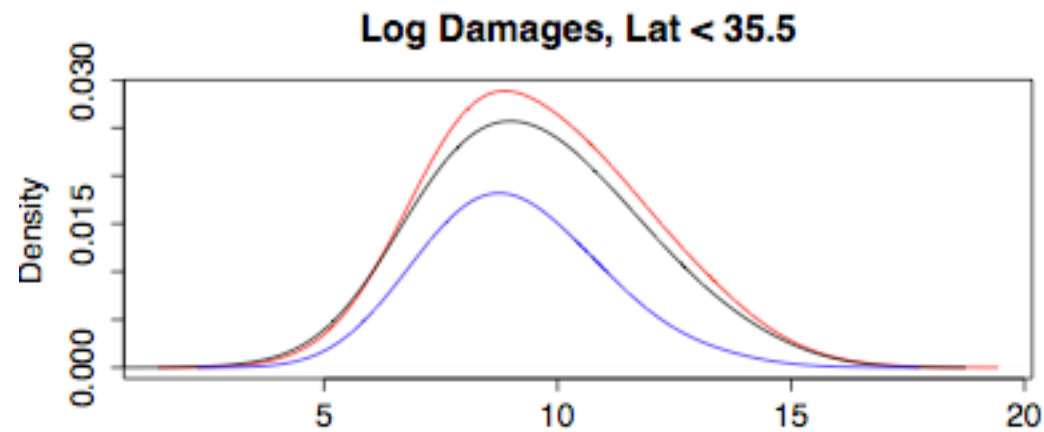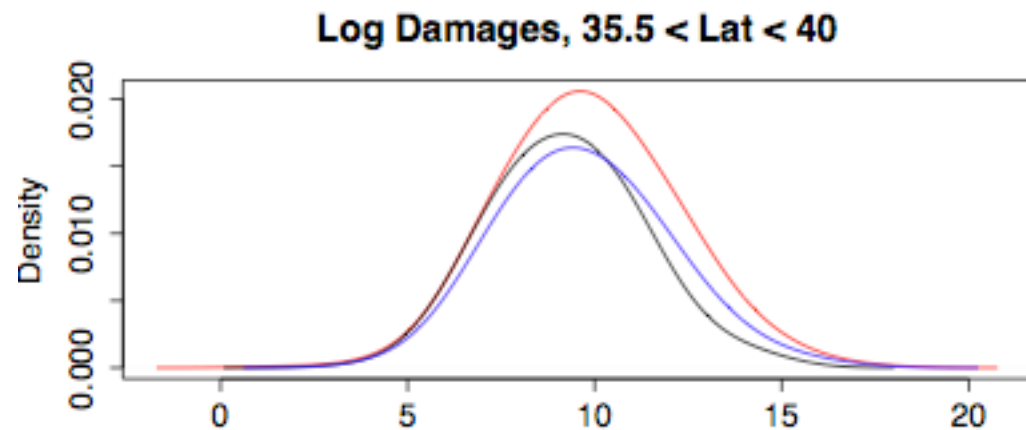
Intraseasonal Climate Variaton and Claims

- We examine the link between intraseasonal climate variation and claims and damages.
- Extratropical storms ("Pineapple Express" events) cause a strong increase in number of claims and damages.

	Average Winter Month	Non-Pinepple Express Month	Pineapple Express Month
Claims Paid			
Median	2	1	11
Mean	58	42	159
Real Payments			
Median	$7,476	$4,280	$91,850
Mean	$1,046,120	$719,983	$3,166,015

Intraseasonal Climate Variaton and Claims

Difference in Frequencies of Flood Events in "Pineapple" Months vs. "Non-Pineapple" Months

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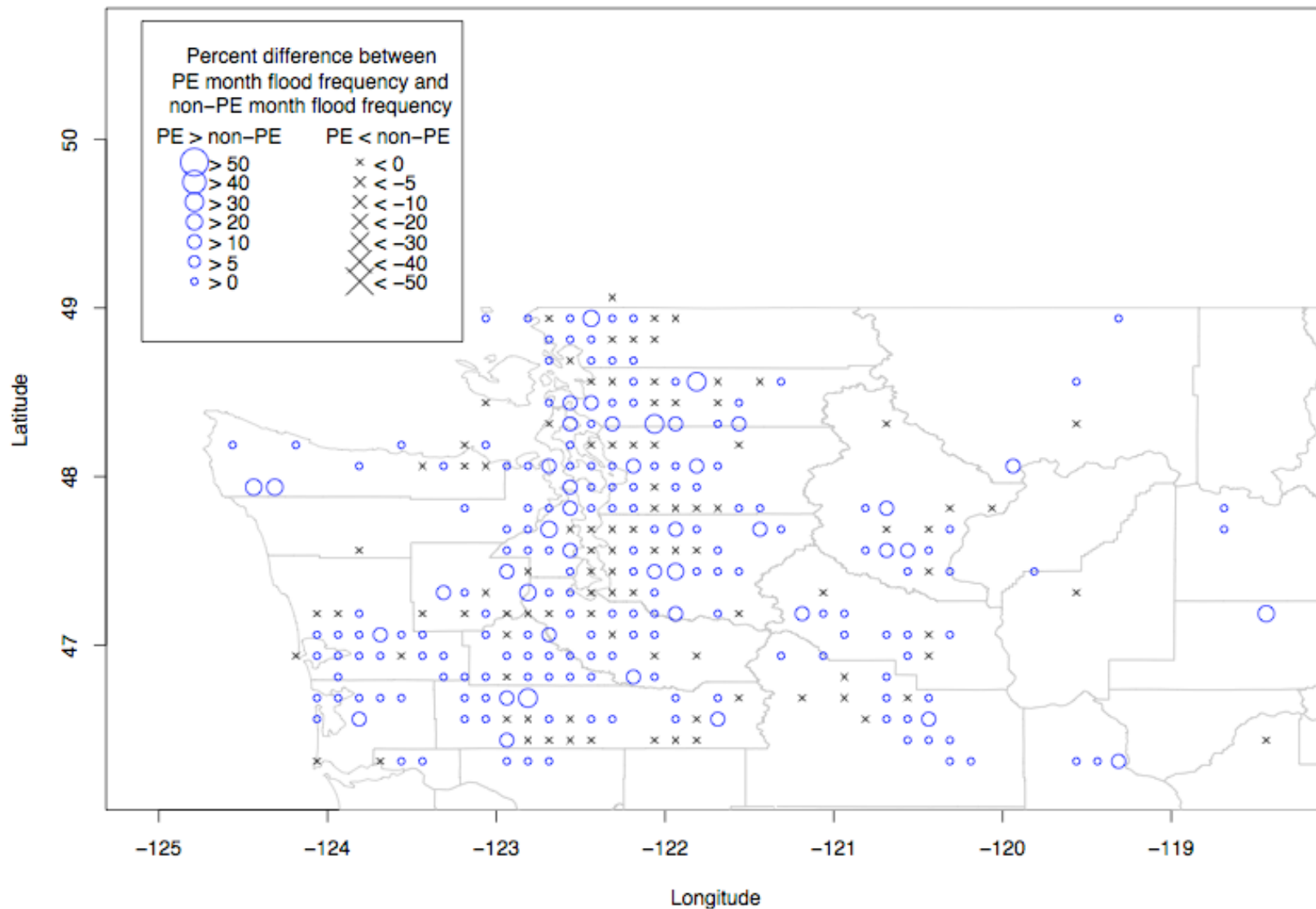
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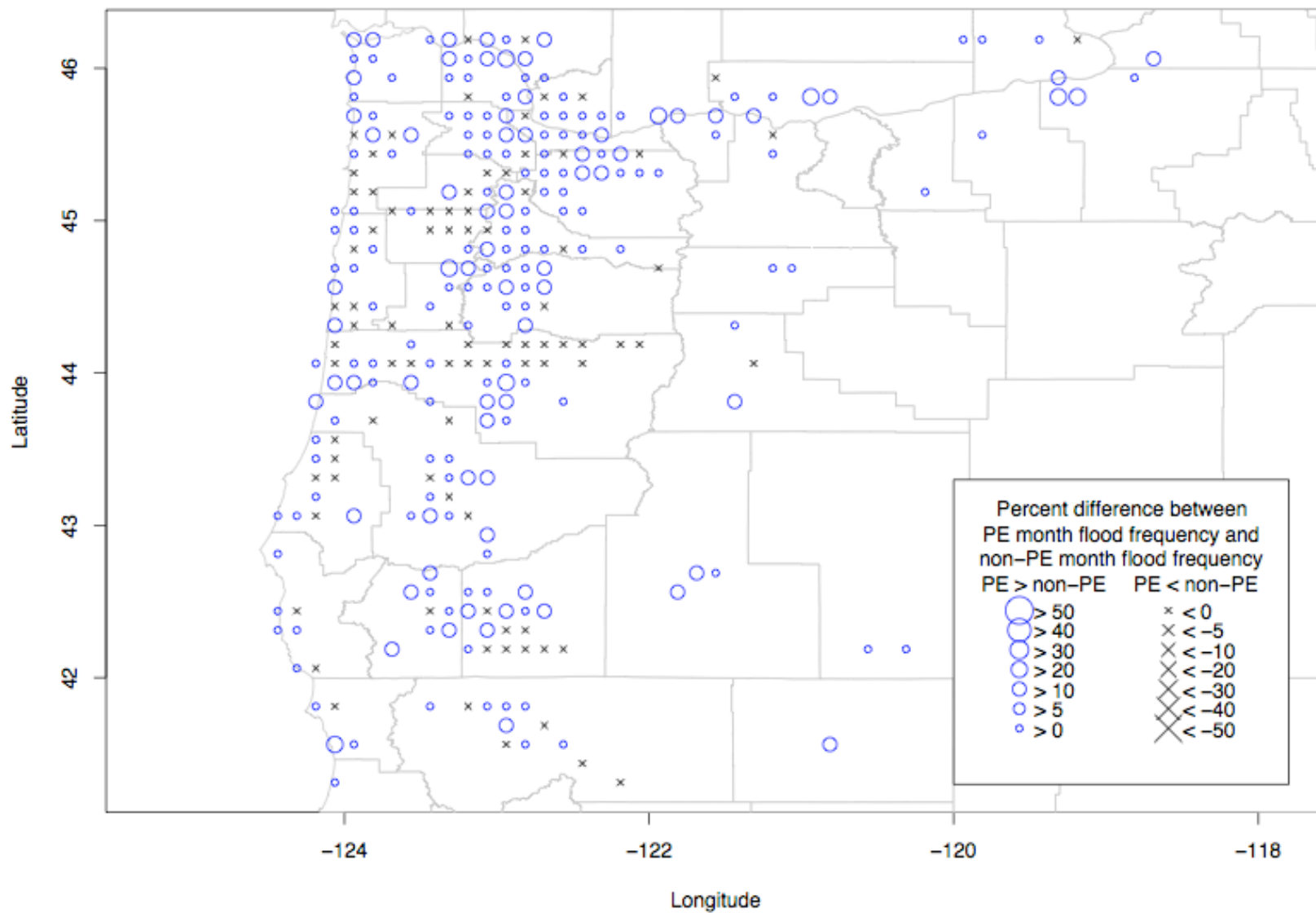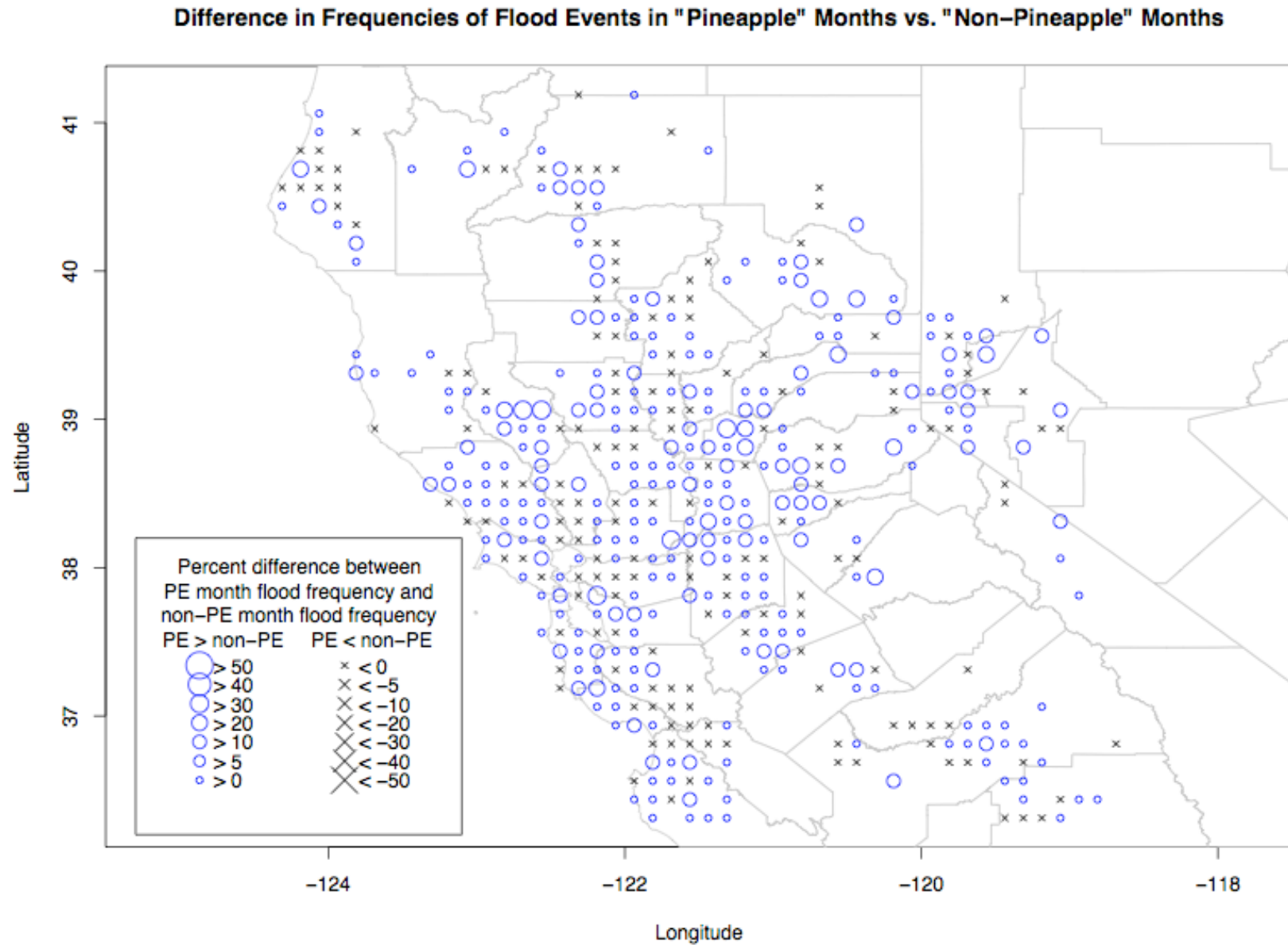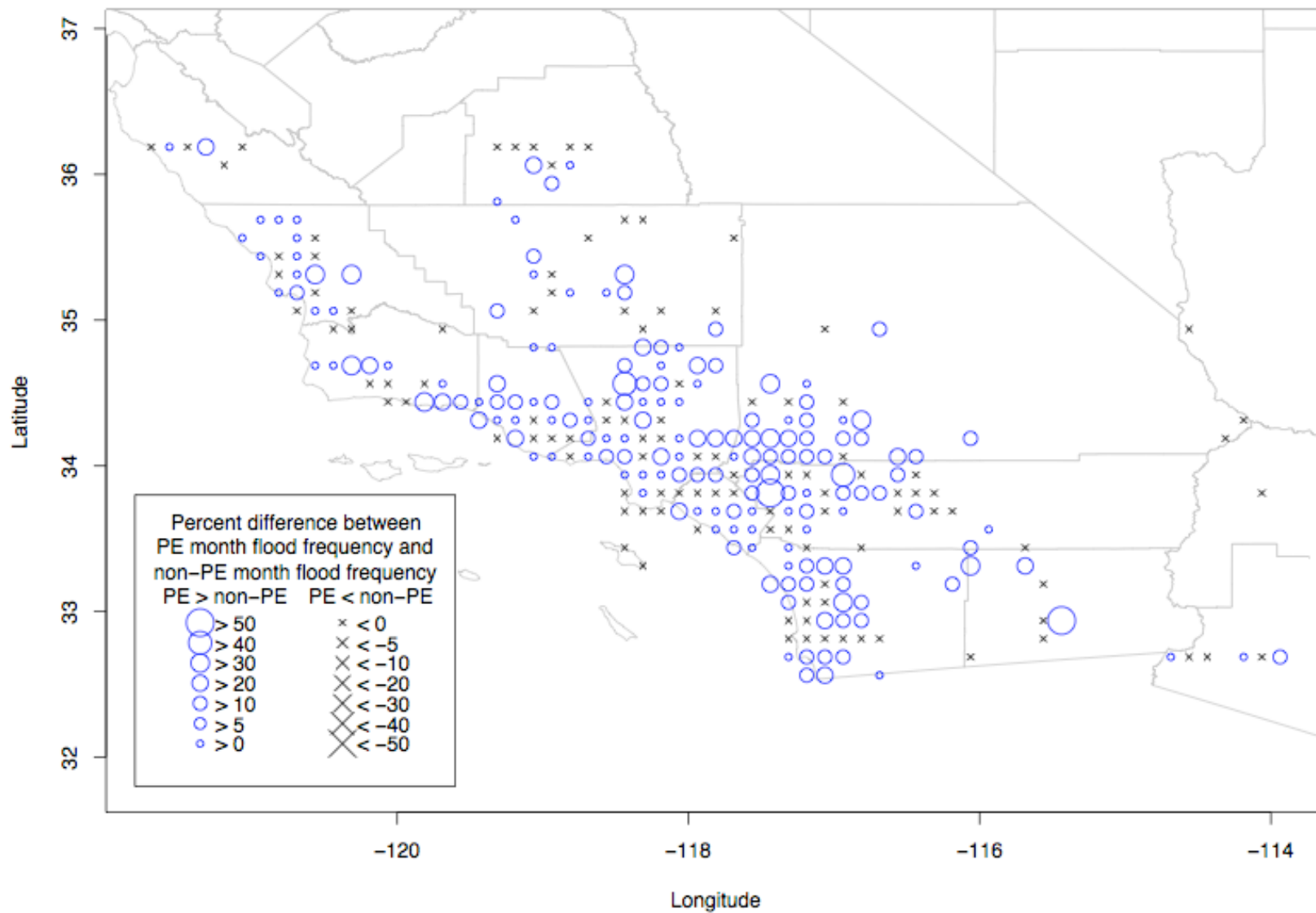
Largest Events

Event Dates	Real Losses ($m)	Claims	ENSO Nino3.4	PDO	PE (Bands)
January 3 - 14, 1995	84.27	4931	Strong EN 1.04	Cool -0.49	North 3, 4
December 28, 1996 - January 8, 1997	70.44	3302	LN -0.45, -0.55	Neutral -0.03, 0.23	All 1, 2, 3; 1, 3, 4
February 1 - 14, 1996	70.16	2961	Strong LN -0.85	Neutral 0.75	All 1, 2, 3, 4
January 29 - February 26, 1998	55.90	5591	Strong EN 2.59, 2.17	Warm 0.83, 1.56	No
February 12 - 25, 1986	53.02	2619	Strong LN -0.75	Warm 1.61	All 1, 2, 3, 4
March 5 - 15, 1995	41.21	2560	EN 0.48	Warm 0.75	South 1,2
January 22-29, 1983	22.27	1593	Strong EN 2.85	Neutral 0.56	North 3
February 13-24, 1980	22.22	2103	EN 0.49	Warm 1.32	Mixed 1, 4
February 25 - March 6, 1983	19.31	1856	Strong EN 1.14, 2.44	Warm 1.89, 2.11	Mixed 1, 3, 4; 1, 3
January 4, 1982	17.88	1396	Neutral 0.21	Neutral 0.34	North 4

Table 1: Top Ten Western Flooding Events 1978 - 2004

Matching Flood Damages to Census Data

- We also match flood claims to decennial census data from 1980, 1990, 2000.

- There are some interesting results: over our sample period, the rate of return on flood insurance is less than negative 30 percent over the entire Western 11 states:
  - Are western policyholders subsidizing the Gulf Coast?
  - Or have we been lucky this past 26 years?

- High damages are associated with low-income, high poverty, low education areas.

- Participation rates are below 50 percent in the highest risk areas, even following reforms of the National Flood Insurance Program to require insurance in high risk areas.

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